NASA CONTRACTOR REPORT 166584

Astronomical Application of IR CID Technology
Final Report

David M. Rank

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April 1984

NASA

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Astronomical Application of IR CID Technology
Final Report

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Prepared for
Ames Research Center
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National Aeronautics and
Space Administration

Ames Research Center
Moffett Field, California 94035

0	0
1	-32.8809219
2	-72.3380262
3	39.4571063
4	32.8809219
5	0
6	13.1523688
7	26.3047375
8	6.57618438
9	-39.4571063
10	-26.3047375
11	-46.0332906
12	-59.1856594
13	6.57618438
14	6.57618438
15	0
16	-59.1856594
17	0
18	92.0665813
19	40154.1816
20	68052
21	85726.8148
22	69720.189
23	70816.3765
24	62346.9884
25	78.9142126
26	144.676056
27	57086.8673
28	51534.1017
29	50149.0153
30	41007.75
31	47957.6025
32	44486.2556
33	38161.2223
34	37715.1045
35	37176.4401
36	36549.4643
37	31678.8847
38	33297.2215
39	29823.5535
40	27606.822
41	29105.7275
42	28120.4593
43	26244.1596
44	24830.6701
45	25905.1691
46	25297.4453
47	26184.6936
48	21671.5823
49	23215.9075
50	24026.8894
51	624.737516
52	414.299616
53	203.861716
54	111.795134
55	-6.57618438
56	-6.57618438
57	-39.4571063
58	-26.3047375
59	13.1523688
60	138.099872
61	0
62	-59.1856594
63	-19.7285531

$\frac{\chi C_{1/q}2}{\mu Cep\,2}$

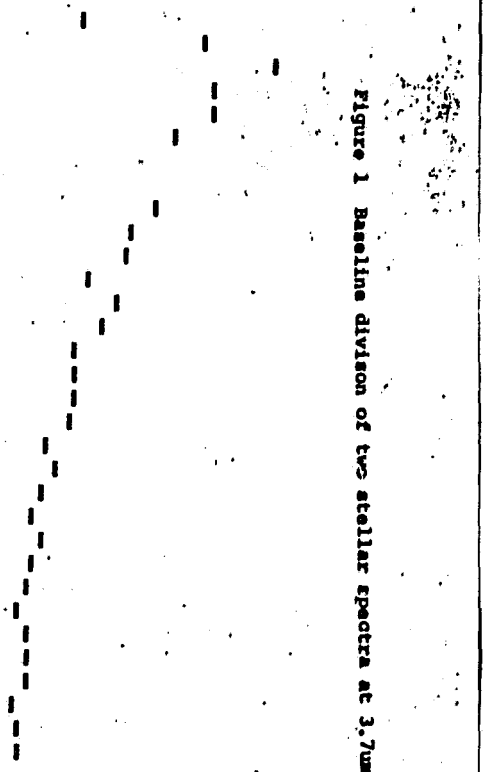


Figure 1 Baseline divison of two stellar spectra at 3.7μm

XE#
CH#

	VALUE
0	384
1	11
2	1
3	3
4	2
5	2
6	6
7	-30
8	-12
9	9
10	5
11	9
12	9
13	-6
14	-3
15	8
16	0
17	17
18	5
19	43
20	328
21	285
22	140
23	553
24	1774
25	216
26	32
27	4
28	16
29	7
30	9
31	-24
32	1647
33	317
34	147
35	96
36	33
37	-7
38	237
39	11883
40	-123
41	428
42	1153
43	6293
44	6385
45	694
46	285
47	228
48	40
49	37
50	9
51	5
52	12
53	6
54	2
55	-4
56	-1
57	-7
58	-16
59	0
60	8
61	8
62	11

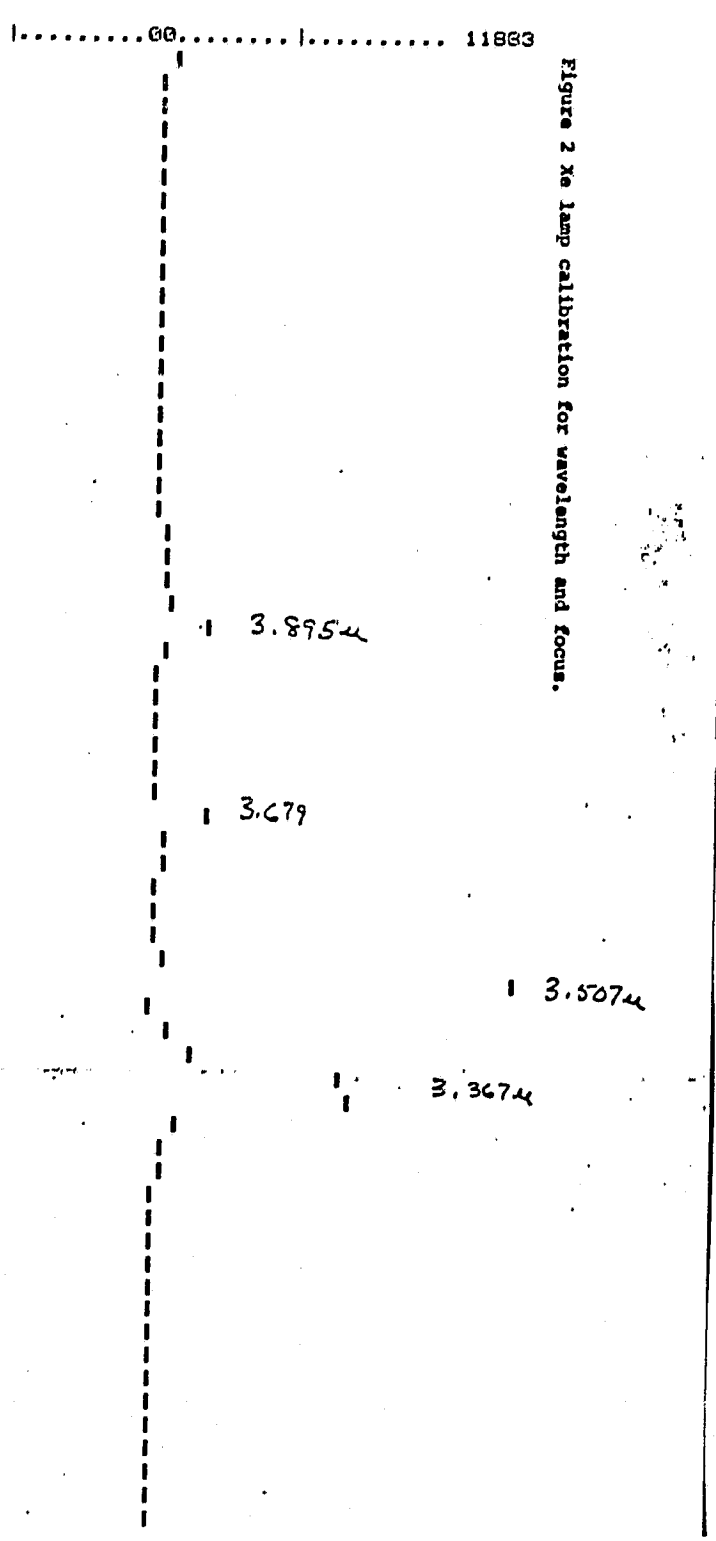


Figure 2 Xe lamp calibration for wavelength and focus.

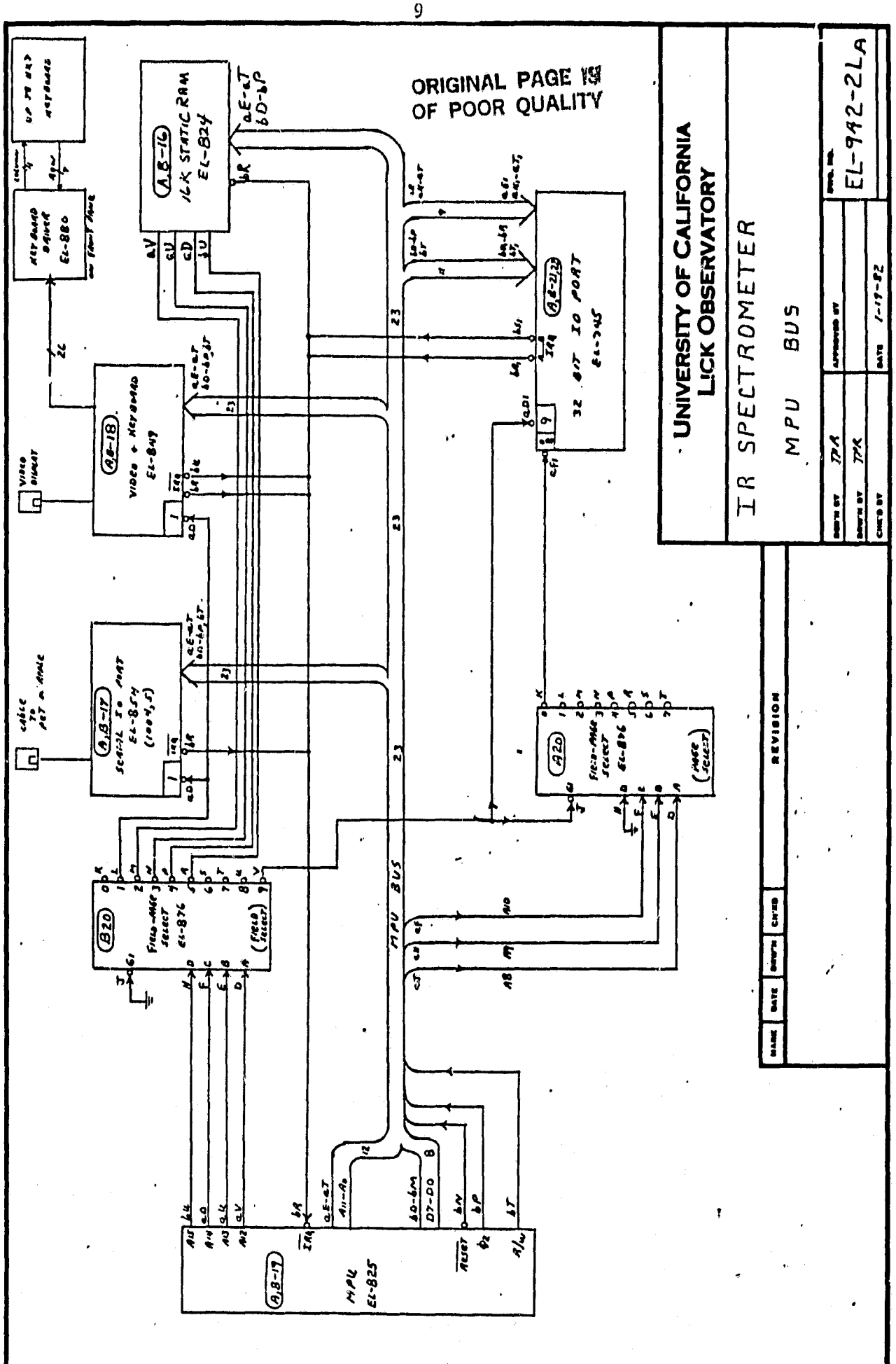
Appendix A

```
]0 SYS]6402
20 POKE52,0:POKE53,64
30 DIM DA(64),DN(64),DD(64),BB(64)
40 POKE ]6586,0
50 DB=5*4096:D2=DB+256:REM.DATA BUFFERSDSAVE"CID]"
55 C]=256:C2=DB+64:C3=256 2:C4=DB+]28:C5=256 3
60 C6=DB+]92:C7=D2+64:C8=D2+]28:C9=D2+]92
]00 REM..PARAMETERS
]]0 A(8)=64:REM..# OF DETECTORS
]20 A(7)=]:REM..# OF DET CYCLES
]30 INPUT"# OF CHOPS  ";NC
]35 A(6)=INT(NC/256):A(5)=NC-256*A(6)
]40 A(4)=2:REM..A/D DELAY
]50 A(3)=0:A(2)=]:REM..CHOPPER DELAY
]60 A(])=250:REM..# OF CHOPS BEFORE DATA BAD SUBSCRIPT
200 PRINT"S"
205 FORJ=]TO]00:NEXT
2]0 PRINT"S COMMAND IRASLDBPC"
2]5 GET CM$:IF CM$=""THENFORJ=]TO]00:NEXTJ:PRINT"SR COMMANDr";GOSUB]000:GOTO205
2]7 IF CM$  ""THENPRINT"SQQQLAST COMMAND WAS R"CM$"r":PRINT"S"
220 IFCM$="I"THENCM$="S":GOSUB400:CM$=""
240 IF CM$="R" THEN GOSUB 500
245 IFCM$="D"THENGOSUB6000
250 IF CM$="A"THEN GOSUB 500
255 IFCM$="C"THENGOSUB8000
260 IFCM$="L"THENGOSUB4000
265 IFCM$="P"THENGOSUB7000
270 IFCM$="S"THENGOSUB3000
275 IFCM$="B"THENGOSUB5000
290 GOTO 2]0
400 FORJ=]TO8
4]0 POKE]6384+J,A(J)
4]5 NEXT J
420 SYS]64]5
430 GOSUB 700
500 POKE]6394,ASC(CM$)+32
5]0 SYS]6555
520 GOSUB 700
550 RETURN
700 ER=PEEK(]6384)
705 RETURN
7]0 IF ER=99 THEN PRINT"CHECKSUM ERROR"
720 IF ER=]0] THEN PRINT"ACIA ERROR"
725 A$="
790 RETURN:REM..SYS]6587:REM..CHECK ACIA
]000 REM..CHECK ACIA
]004 SYS]6587
]005 TE=PEEK(]6586):IFTE=0THEN RETURN
]006 POKE]6586,0
]007 IF TE=32THENCN=0:PRINT"SQQQ)))))))))))))))))))";"     ":RETURN
]008 CN=CN+]
]009 PRINT"SQQQ)))))))))))))))))))";CN
]0]0 GOSUB 700
]0]7 MA=0
]020 FOR J=0TOA(8)-]
]030 DA(J)=PEEK(DB+J)+C]*PEEK(C2+J)+C3*PEEK(C4+J)+C5*PEEK(C6+J)
]040 DN(J)=PEEK(D2+J)+C]*PEEK(C7+J)+C3*PEEK(C8+J)+C5*PEEK(C9+J)
```

```
]050 DD(J)=DA(J)-DN(J)
]05] DD(0)=.]:DD(])=.]:DD(62)=.]:DD(63)=.]
]052 IF ABS(DD(J)) ABS(MA)THEN MA=ABS(DD(J))
]055 NEXT J
]060 GOSUB 2000
]090 RETURN
2000 PRINT"SQQQ" :REM...PLOT ON SCREEN
2002 IFMA=0THENMA=]0
2003 FORJ=4TO23:PRINT"                                        ":NEXTJ
2004 PRINT"                                S";
2005 SC=20/MA:S0=33728:LL=40
20]0 FOR J=0TO62 STEP 2
20]5 IJ=INT(J/2)
2020 P]=INT(DD(J)*SC)+20:P2=INT(DD(J+])*SC)+20:I]=INT(P]/2):I2=INT(P2/2)
2025 IFI] 0THENI]=0:IFI2 0THENI2=0
2030 IF I]=I2 GOTO 2]00
2040 IF I] P]/2 THEN POKE S0+IJ-I]*LL,]26:GOTO 2060
2050 POKE S0+IJ-I]*LL,]23
2060 IF I2 P2/2 THEN POKE S0+IJ-I2*LL,]24:GOTO 2]00
2070 POKE S0+IJ-I2*LL,]08
2090 GOTO 2300
2]00 IFP]=P2ANDI]=P]/2THENPOKE S0+IJ-I]*LL,98:GOTO2300
2]]0 IFP]=P2ANDI] P]/2THENPOKE S0+IJ-I]*LL,226:GOTO2300
2]20 IF P] P2 THEN POKE S0+IJ-I]*LL,255:GOTO2300
2]30 POKE S0+IJ-I]*LL,]27
2300 NEXT J
2302 PRINT"SQ))))))))))))))))))))))))))))";"          ";
2303 IFTE=]00THENPRINT"SQQQ";"INTEGRATION OVER    ";")))";"*";A(]);"CPS"
2305 PRINT"SQ))))))))))))))))))))))))))))";"MAX";MA
23]0 RETURN
3000 REM..SAVE DATA
3003 PRINT"S";"                                    "
3005 PRINT:INPUT"FILE NAME";FL$
3020 DOPEN#8,(FL$),W:IF DS  0 THEN9]00
3030 FORJ=20480TO20992
3040 A$=STR$(PEEK(J))
3050 PRINT#8,A$;CHR$(]3);:IFDS ]9THEN9]00
3060 NEXTJ
3070 DCLOSE#8
3080 GOTO2]0
4000 REM LOAD DATA
4002 GOSUB4005
4003 GOTO]0]7
4005 PRINT"S";"                                    "
40]0 PRINT:INPUT"FILE NAME";FL$:IF FL$="S"THEN8500
40]5 IFFL$="E"THEN8320
4030 DOPEN#8,(FL$): IF DS  0 THEN 9000
4040 FORJ=20480TO20992
4045 INPUT#8,A$:IFDS ]9THEN9000
4060 POKEJ,VAL(A$)
4070 NEXTJ
4080 DCLOSE#8
4090 RETURN
5000 REM SET BB
50]0 FORJ=0TOA(8)-]:BB(J)=DD(J):NEXTJ
5020 RETURN
6000 FORJ=0TOA(8)-]:IFBB(J)=0THENBB(J)=]00000
600] NEXT J
6005 FORJ=27TO52:DD(J)=DD(J)*C2/BB(J)
60]0 IFMA DD(J)THENMA=DD(J)
6020 NEXTJ
6023 FORJ=0TO26:DD(J)=.]:NEXT
6025 FOR J=53TOA(8)-]:DD(J)=.]:NEXT
6030 GOTO2000
```

```
7000 IFMA=0THENRETURN
7010 OPEN4,4:CMD4
7015 A$="
7020 PRINTFL$
7025 PRINT"CH#              VALUE          ).........00.........).........";MA
7040 FORJ=0TO A(8)-]:SC=40/MA:LL=DD(J)*SC+80 :LL=INT(LL)
7045 PRINTJ,DD(J);CHR$(]4));LEFT$(A$,LL/2);
7048 IFLL/2=INT(LL)THENPRINT"5"
7050 PRINT"6"
7055 NEXTJ
7060 CLOSE4
7070 RETURN
8000 REM COADD SCANS
8005 FORJ=0TOA(8)-]:DD(J)=0:DA(J)=0:DN(J)=0:NEXTJ:MA=0:ER=0
8010 GOSUB4005
8020 PRINT"S +,-,E,S,D..?          "
8022 FORJ=]TO500:NEXTJ
8024 PRINT"S +,-,E,S,D..    "
8026 GETCM$:IFCM$=""THENFORJ=]TO500:NEXTJ:GOTO8020
8040 IFCM$="+"THENPRINT"q)))))))))))))))) +":GOTO8]00
8050 IFCM$="-"THENPRINT"q)))))))))))))))) -":GOTO8200
8060 IFCM$="E"THEN8300
8070 IFCM$="S"THENPRINT"q)))))))))))))))) S":GOTO8500
8080 IFCM$="D"THEN8600
8090 GOTO8026
8]00 MA=0:FORJ=0TOA(8)-]
8]05 DA(J)=DA(J)+PEEK(DB+J)+C]*PEEK(C2+J)+C3*PEEK(C4+J)+C5*PEEK(C6+J)
8]]0 DN(J)=DN(J)+PEEK(D2+J)+C]*PEEK(C7+J)+C3*PEEK(C8+J)+C5*PEEK(C9+J)
8]20 DD(J)=DA(J)-DN(J)
8]30 IFABS(DDJ(J)) ABS(MA)THENMA=ABS(DD(J))
8]40 NEXTJ
8]50 GOSUB2000
8]55 ER=ER+]
8]60 GOTO80]0
8200 MA=0:FORJ=0TOA(8)-]
8205 DN(J)=DN(J)+PEEK(DB+J)+C]*PEEK(C2+J)+C3*PEEK(C4+J)+C5*PEEK(C6+J)
8210 DA(J)=DA(J)+PEEK(D2+J)+C]*PEEK(C7+J)+C3*PEEK(C8+J)+C5*PEEK(C9+J)
8220 DD(J)=DA(J)-DN(J)
8230 IFABS(DDJ(J)) ABS(MA)THENMA=ABS(DD(J))
8240 NEXTJ
8250 GOSUB2000
8255 ER=ER+]
8260 GOTO80]0
8300 IFER/2=INT(ER/2)THEN2]0
8310 PRINT"SNOT EVEN # SCANS":FORJ=]TO]000:NEXTJ:GOTO80]0
8320 PRINT"SSAVE SUM BUFFER ? Y/N      "
8330 GETCM$
8340 IFCM$="Y"THEN8500
8350 IFCM$="N"THEN2]5
8360 GOTO8330
8400 GOTO2]5
8500 FORJ=0TOA(8)-]
8510 P]=INT(DA(J)/C5):POKE(C6+J),P]
8515 P2=INT((DA(J)-P]*C5)/C3):POKE(C4+J),P2
8520 I]=INT((DA(J)-P]*C5-P2*C3)/C]):POKE(C2+J),I]
8530 I2=INT((DA(J)-P]*C5-P2*C3-I]*C])):POKEDB+J,I2
8540 P]=INT(DN(J)/C5):POKE(C9+J),P]
8545 P2=INT((DN(J)-P]*C5)/C3):POKE(C8+J),P2
8550 I]=INT((DN(J)-P]*C5-P2*C3)/C]):POKE(C7+J),I]
8560 I2=INT((DN(J)-P]*C5-P2*C3-I]*C])):POKED2+J,I2
8570 NEXTJ
8580 GOTO3000
8600 DIRECTORY00
```

```
 8610 PRINT"ANY KEY TO RETURN"
 8620 GETCM$:IFCM$=""THEN8620
 8630 GOTO8024
 9000 REM DISK INPUT ERR..
 9010 PRINT"S";DS$
 9020 DCLOSE#8: GOTO4010
 9100 REMDISK OVERFLOWPUT ERROR
 9110 PRINT"S";DS$
 9120 FORJ=1TO2000:NEXTJ
 9130 DCLOSE#8:GOTO3000
READY.
```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IR SPECTROMETER
MPU BUS
EL-942-2LA
REVISION
A8-16
16K STATIC RAM
EL-824
A8-18
VIDEO + KEYBOARD
EL-849
A8-17
SERIAL I/O PORT
EL-845
A8-23
32 BIT I/O PORT
EL-945
A8-17
MPU
EL-825
A20
FIELD-MAKE SELECT
EL-876
MPU BUS

FUNCTION			PAGE 0,8	PAGE 1,9	PAGE 2,A	
RAM			9000-90FF	9100-91FF	9200-92FF	RAM
IO PORTS	PA(1)	IO PORT	9800	9900	9A00	ADD 0020 TO OBTAIN IO PORTS PA(2) + PB(2) — PORTS
		DIRECT. REG	9801	9901	9A01	
	PB(1)	IO PORT	9802	9902	9A02	
		DIRECT. REG.	9803	9903	9A03	
PAT (1) INTERRUPT STATUS	ENABLE OR DISABLE SETTING INTERRUPT	TRANSITION TO SET FLAG				1) WRITE MUST BE ON — DATA ON BUS IS IGNORED 2) ADD 0020 TO OBTAIN PA(2)-7 — PULSE DETECT ON PAT
	DISABLE	↓	9804	9904	9A04	
	DISABLE	↑	9805	9905	9A05	
	ENABLE	↓	9806	9906	9A06	
	ENABLE	↑	9807	9907	9A07	
TIMER INTERRUPT STATUS	DISABLE	IRQ(1)	9810	9910	9A10	
	ENABLE	IRQ(1)	9818	9918	9A18	
TIMER (1)	READ	WRITE TIME +				1) ADD 0008 TO ENABLE INTERRUPT 2) ADD 0020 TO OBTAIN TIMER (2) — TIMERS
	TIME	DECREMENT EVERY ϕ_2	9814	9914	9A14	
	FLAGS	" " 8 ϕ_2	9815	9915	9A15	
	TIME	" " 64 ϕ_2	9816	9916	9A16	
	FLAGS	" " 1024 ϕ_2	9817	9917	9A17	

7	6	5	4	3	2	1	0	INTERRUPT FLAGS
T	P	0	0	0	0	•	•	

T = TIMER FLAG
P = PAT FLAG

CARD #1	CARD #2	CARD #3

NOTE:
ADDRESSES ASSUME PORTS ARE IN FIELD 9 + SELECTED NORMALLY.

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10

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IO PORT ADDRESSING

MARK	DATE	DRW'N	CH'KD	REVISION

DRW'N BY TPR	APPROVED BY	DWG. NO. EL-745-2D$_B$
DRW'N BY TPR		
CHK'D BY	DATE 12-4-80	

PIN		PLAT		PAGE 8		ADDRESS
a	D2	# 7	0	CIO CLOCK		9800
	E2	6	0	CIO SELECTED		
	F2	5				
	H2	4	1	ADC START		
	J2	PA (1) 3	0	12	MSB	
	K2	2	0	11		
	L2	1	0	10		
	M2	0	0	9		D.A. = 9801
a	N2	7	0	8		
	P2	6	0	7		
	A2	5	0	6	12 BIT ADC	9802
	S2	PB 4	0	5		
	T2	(1) 3	0	4		
	U2	2	0	3		
	V2	1	0	2		
	V1	0	0	1	LSB	D.A. = 9803
b	D2	# 7	0	CIO DEV. # 1		
	E2	6	1	SOURCE/ $\overline{\text{START}}$		9820
	F2	5	1	SPARE	SOLENOID DRIVERS	
	H2	PA 4	1	FILTER IN		
	J2	(2) 3	1	SPARE		
	K2	2	1	4		
	L2	1	1	2	AMPLIFIER GAIN	D.A. = 9821
	M2	0	1	1		
b	N2	7	1	FWD	STEPPING MOTOR PULSES	1
	P2	6	1	REV		
	A2	5	1	4	CARD SELECT	9822
	S2	PB 4	1	2		
	T2	(2) 3	1	1		
	U2	2	1	4		
	V2	1	1	2	CHANNEL SELECT	D.A. = 9823
	V1	0	1	1		

A,B-21,22

1804		READ		WRITE	
	7	IAR	STATUS	ENAB. ACV. INTER.	CONTROL
	6	PAR. ERR.		2 } XMIT CNTRL	
	5	ACV. OVERRUN		1	
	4	FRAMING ERR.		3 } READ SELECT	
	3	$\overline{\text{ETS}}$		2	
	2	$\overline{\text{DCD}}$		1	
	1	XMIT. ACV. EMPTY		0	
	0	ACV. REC. FULL		0	

1805					
	7	7	RECEIVED DATA	7	DATA TO TRANSMIT
	6	6		6	
	5	5		5	
	4	4		4	
	3	3		3	
	2	2		2	
	1	1		1	
	0	0		0	

ACIA

WORD SELECT

	# BITS	PARITY	# STOP BITS
0	7	EVN	2
1	7	ODD	2
2	7	EVN	1
3	7	ODD	1
4	8	—	2
5	8	—	1
6	8	EVN	1
7	8	ODD	1

XMIT CONTROL

	$\overline{\text{RTS}}$	INTERRUPT	COMMENT
0	0	off	—
1	0	enabled	—
2	1	off	—
3	0	off	BRK sends on xmit out

* NOTE:
PA(1) -7 & PA(2) -7
CAN CAUSE INTERRUPT
ON EITHER TRANSITION
AS INPUTS.

DIA. REG. BITS:

MARK	DATE	DRW'N	CH'KD	REVISION

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IR SPECTROMETER

PORT DESCRIPTIONS

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CHK'D BY	DATE 1-19-82	

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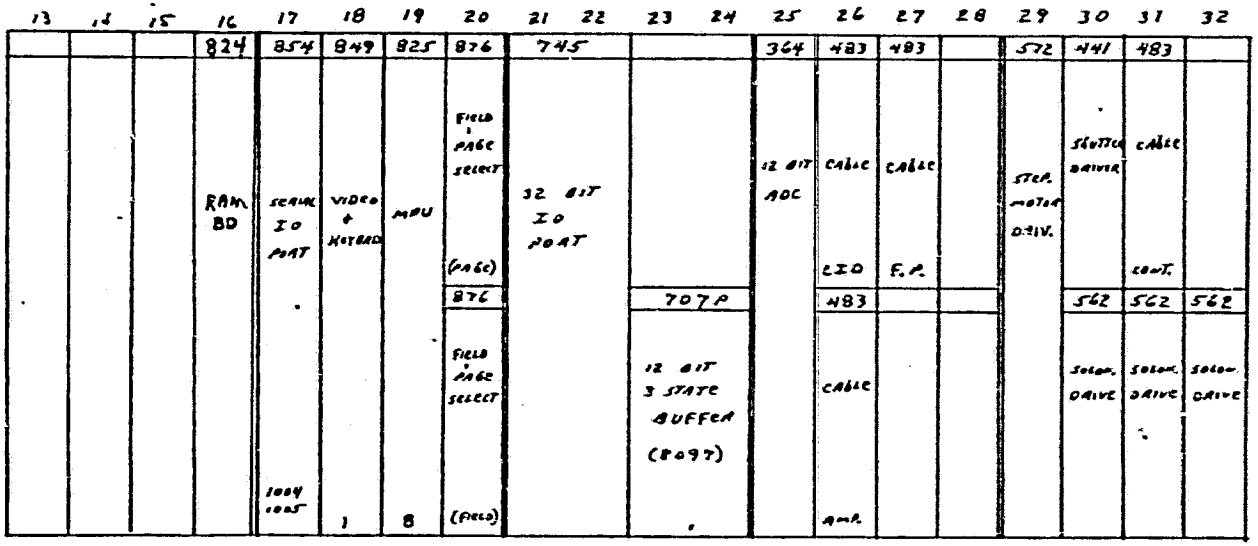

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MODULE UTILIZATION

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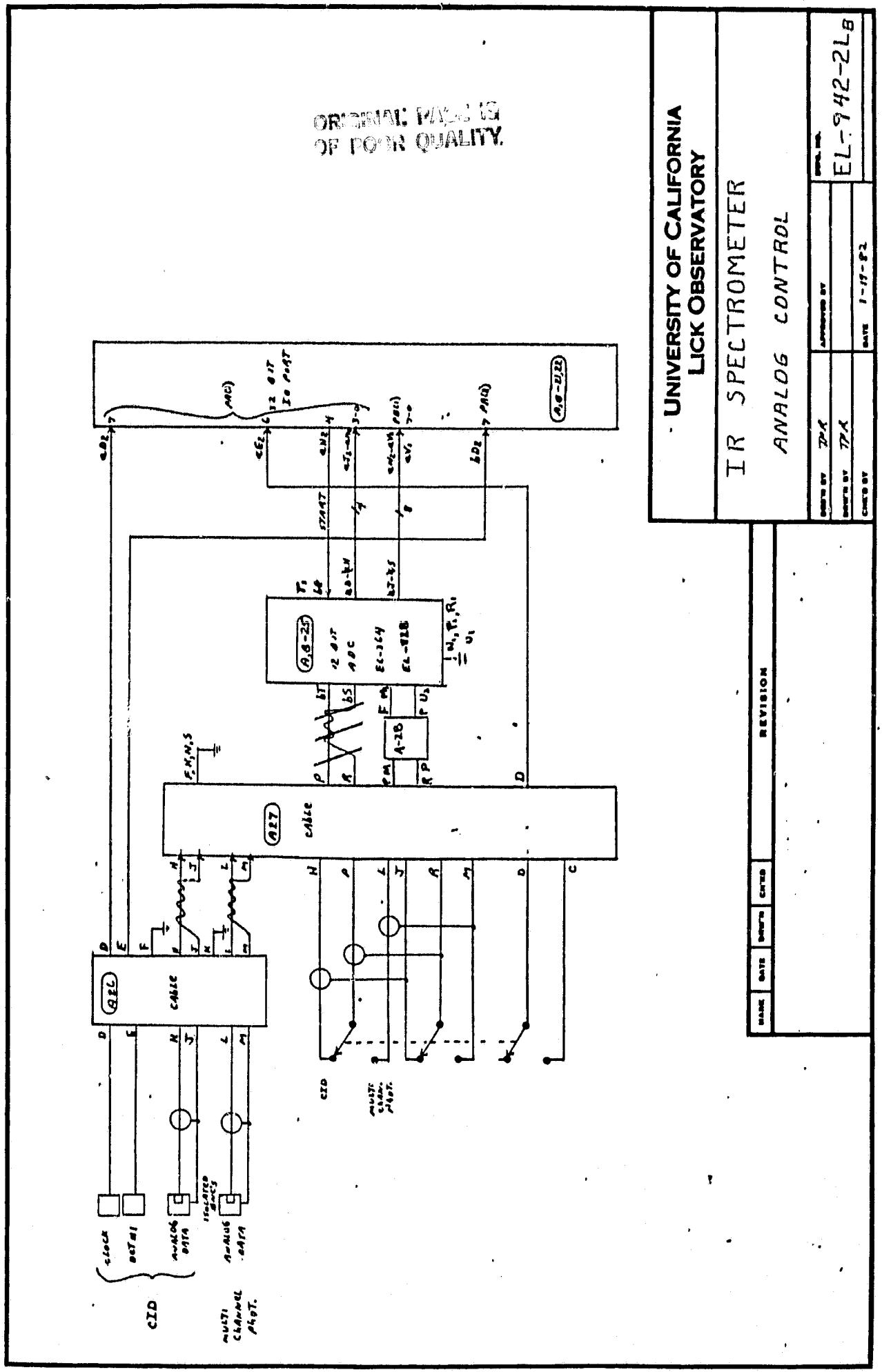

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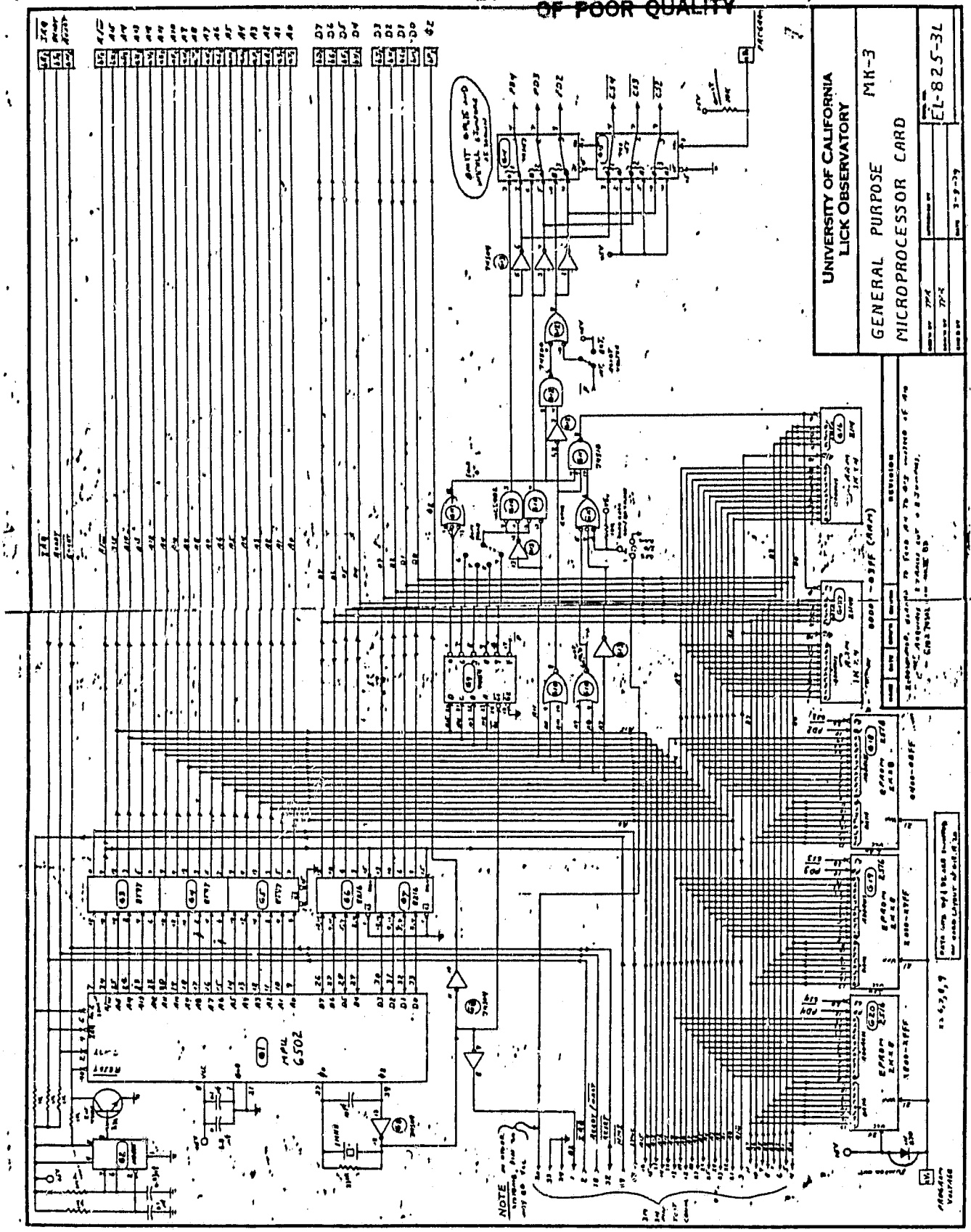

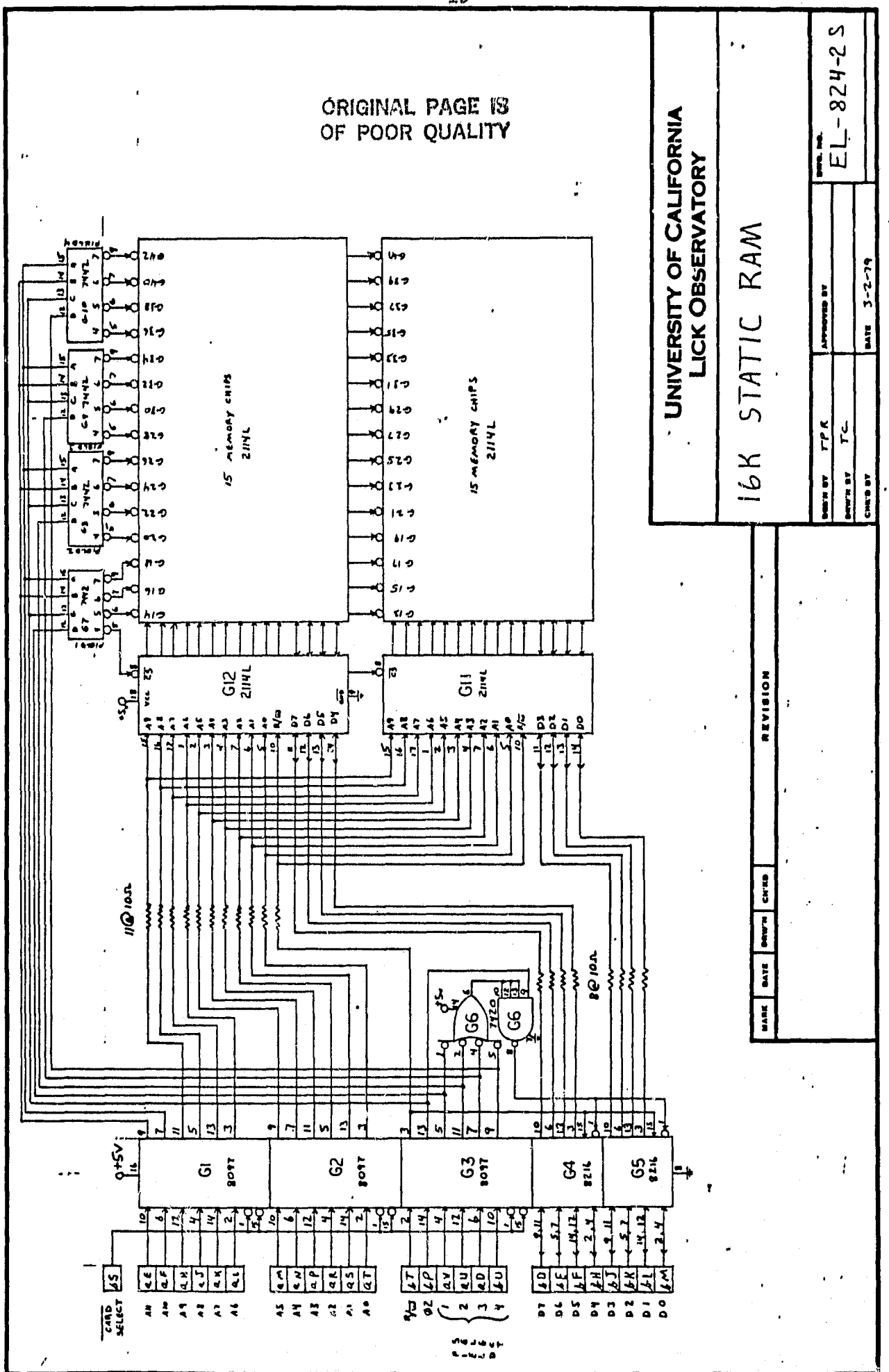

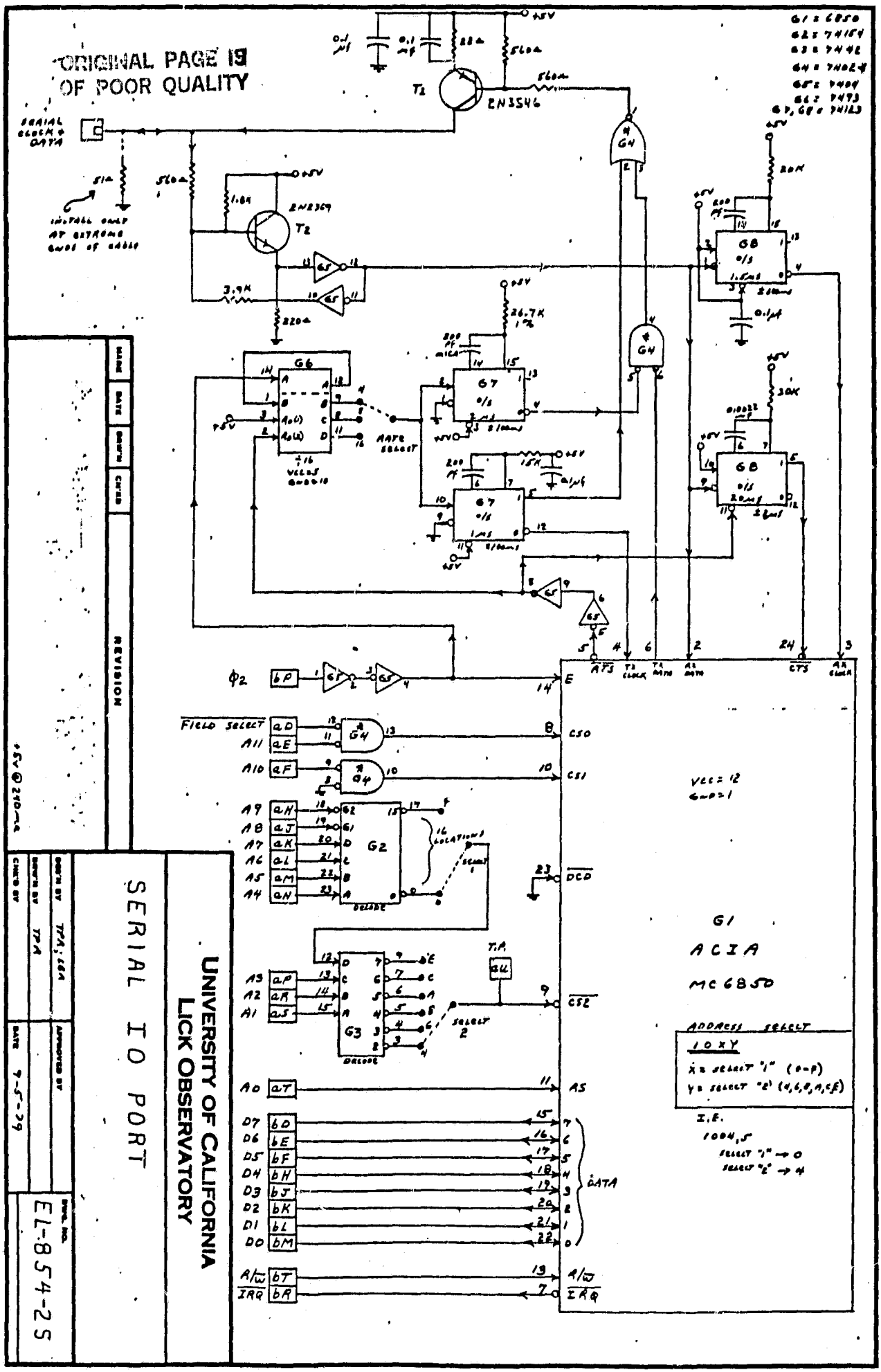

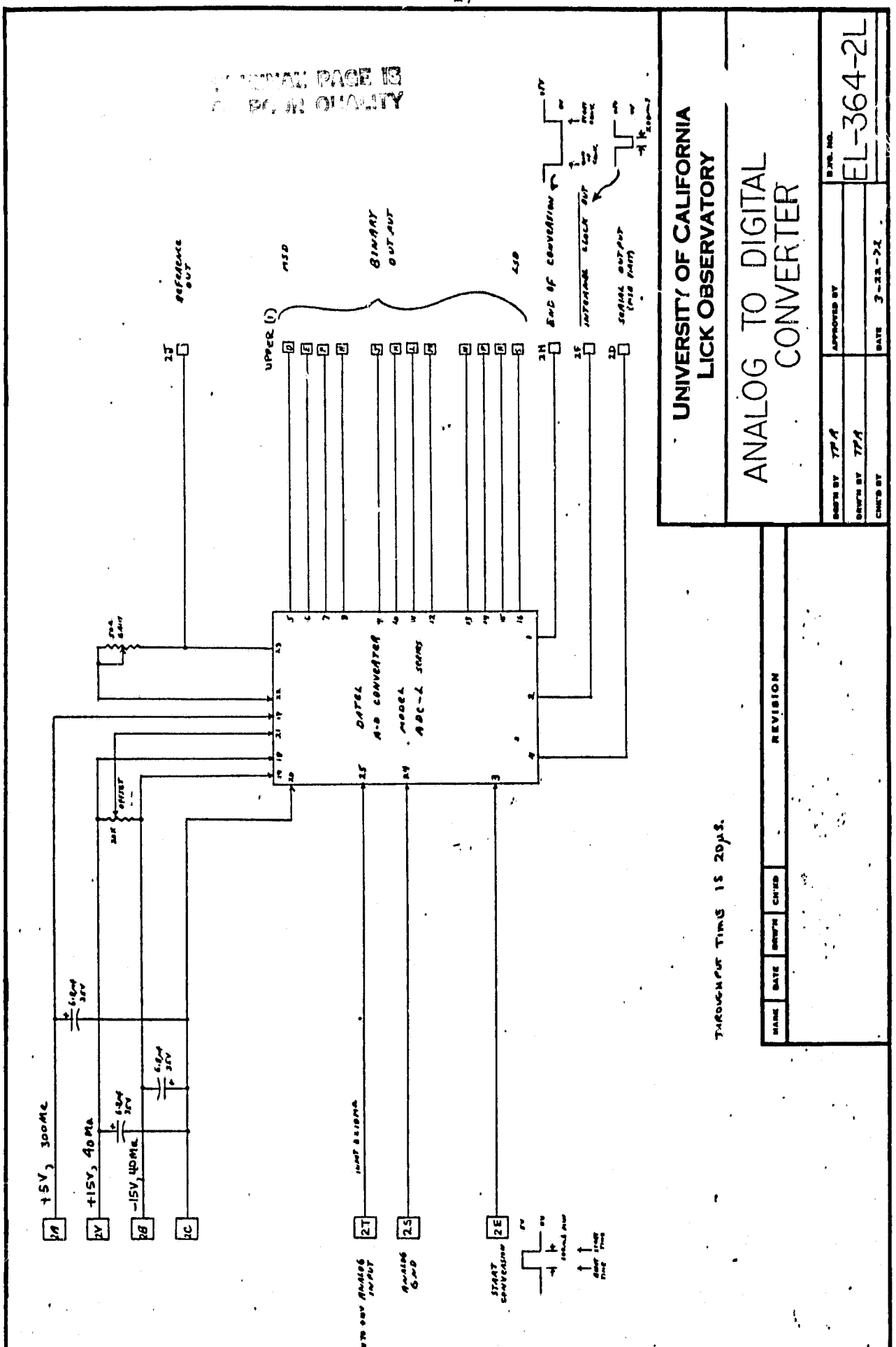

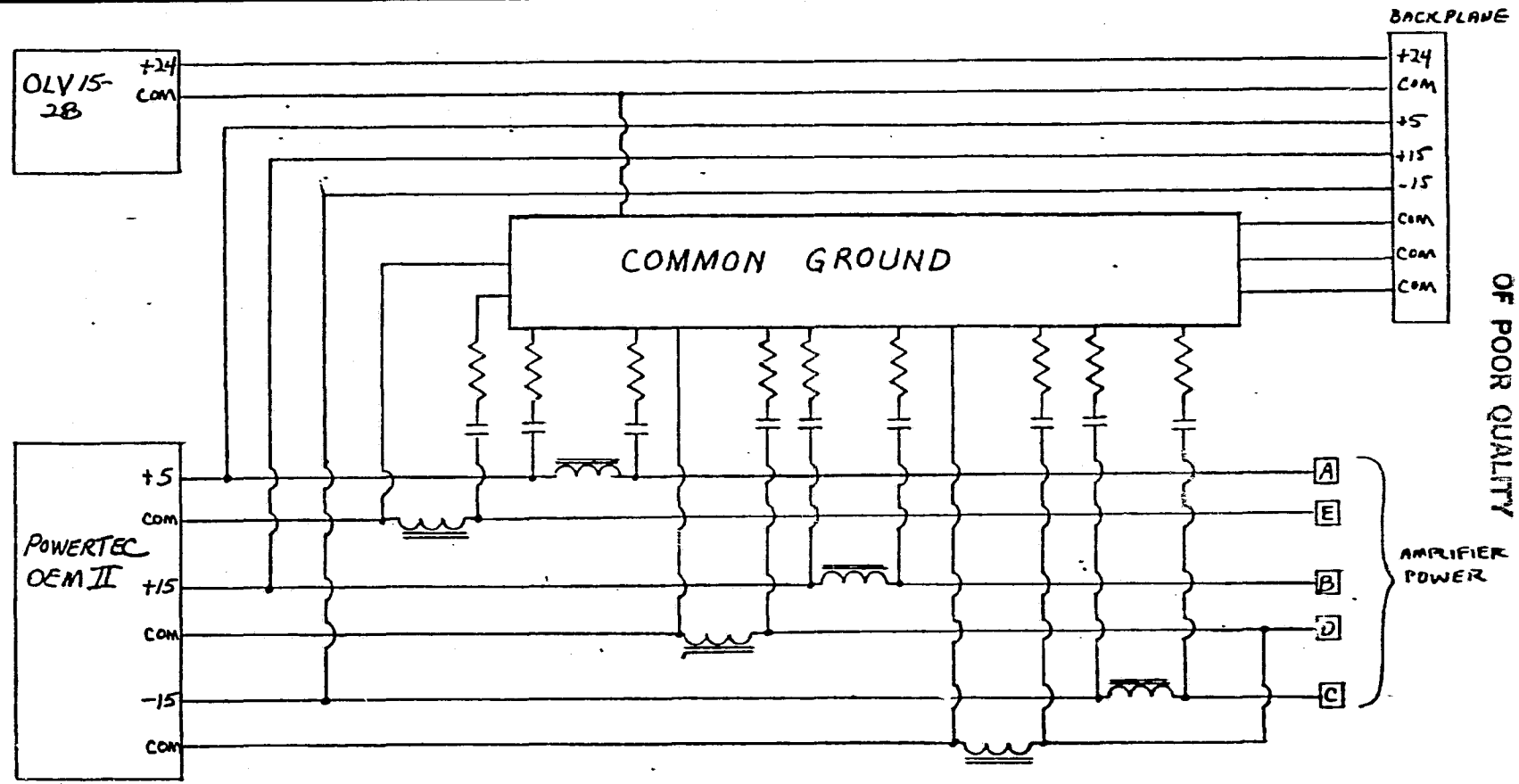

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R = 10Ω
C = 1 mf
L = 1" TOROID

MARK	DATE	DRW'N	CH'ED	REVISION

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POWER SUPPLY FILTERING & DISTRIBUTION

DES'N BY TPR	APPROVED BY	DWG. NO. EL-942-WA
DRW'N BY LP		
CH'K'D BY	DATE 3-29-82	